What is claimed is:

1. A semiconductor device, comprising a substrate having a substrate surface, a barrier film on the substrate surface, and a single crystal transition metal on the barrier film.

2. A semiconductor device according to claim 1, wherein the barrier film has a thickness less than approximately 250Å.

3. A semiconductor device according to claim 1, wherein the barrier film has a thickness less than approximately 100Å.

4. A semiconductor device according to claim 1, wherein the barrier film has a thickness in the range of approximately 20 to approximately 75Å.

5. A semiconductor device according to claim 1, wherein the metal comprises an elemental transition metal.

6. A semiconductor device according to claim 1, wherein the transition metal is selected from the group consisting of copper, silver, gold and platinum.

7. A semiconductor device according to claim 1, wherein the transition metal comprises copper.

8. A semiconductor device according to claim 1, wherein the barrier film comprises a heteroepitaxial film structure comprising a monolayer of metal atoms selected from barium atoms, strontium atoms, and cesium atoms, singly or in combinations thereof, located on said surface of said substrate, and a homoepitaxial portion comprised a metal halide selected from barium halide, strontium halide and cesium halide located between the monolayer and the metal.

9. A semiconductor device according to claim 1, wherein the substrate is selected from the group consisting of single crystal silicon, polycrystalline silicon, SOI, SOS, gallium arsenide, silicon carbide, indium phosphide, gallium nitride, aluminum nitride, germanium, indium antimonide, lead telluride, cadmium telluride, mercury-cadmium telluride, lead selenide, lead sulfide, and tertiary and quaternary combinations of these materials.

10. A semiconductor device according to claim 1, wherein the substrate comprises single crystal silicon.

11. A semiconductor device according to claim 1, wherein the substrate comprises single crystal gallium arsenide.

12. A semiconductor device comprising a single crystal substrate having a substrate surface, a barrier film on the substrate surface, where said barrier film comprises homoepitaxial metal halide and said barrier film having a thickness less than approximately 100Å, and single crystal metal directly on the metal halide.

13. A semiconductor device according to claim 12, wherein the substrate is selected from the group consisting of silicon and silicon oxide, the metal halide is selected from the group consisting of barium halide and strontium halide, and said metal is selected from the group consisting of copper, gold, silver, and platinum.

14. A process for making a semiconductor device comprising the steps of:

forming, on a surface of a substrate material, a barrier film; and

forming a single crystal transition metal on the barrier film.

15. A process for making a semiconductor device according to claim 14, wherein the forming of the barrier film comprises the following substeps:

vapor depositing a metal halide on the cleaned heated substrate surface at a temperature of 500 to 700°C, in a vacuum having a background pressure of less than approximately $10^{-11}$ Torr, and wherein the metal halide deposition is conducted at a rate permitting the metal halide vapor to react with the substrate surface to form a monolayer of metal atoms selected from barium atoms, strontium atoms, and cesium atoms, singly or in combinations thereof, on said surface of said substrate; and

continuing, after forming the monolayer, the vapor depositing of the metal halide to form a metal halide layer regime upon the monolayer until the desired barrier film thickness has been achieved.

16. A process for making a semiconductor device according to claim 14, wherein the forming of the single crystal transition metal on the barrier film comprises depositing a transition metal on the barrier film concurrent with heating the substrate and barrier film surface to a temperature effective to cause the transition metal to assume a monocrystalline structure.

17. A process for making a semiconductor device according to claim 14, wherein the forming of the single crystal transition metal on the barrier film comprises the substeps of depositing a transition metal on the barrier film at a temperature below which the metal forms with a single crystal structure, and then annealing the resulting metallized substrate at a temperature effective to cause the transition metal to assume a monocrystalline structure.

18. A process for making a semiconductor device according to claim 14, wherein the forming of the single crystal transition metal on the barrier film comprises depositing a transition metal on the barrier film concurrent with heating the substrate and barrier film surface to approximately 375°C or higher.

19. A process for making a semiconductor device according to claim 18, wherein the transition metal comprises copper.

20. A process for making a semiconductor device according to claim 14, wherein the forming of the single crystal transition metal on the barrier film comprises the substeps of depositing a transition metal on the barrier film at a temperature below 375°C, and then annealing the resulting metallized substrate at a temperature of 375°C or higher.

21. A process for making a semiconductor device according to claim 20, wherein the transition metal comprises copper.

22. A process for making a semiconductor device according to claim 14, wherein the barrier film comprises a homoepitaxial portion comprised a metal halide selected from barium halide, strontium halide, and cesium halide, located between the monolayer and the transition metal.

23. A process for making a semiconductor device according to claim 14, wherein the homoepitaxial portion of the barrier film is selected from $BaF_2$, $BaCl_2$, $SrF_2$, $SrCl_2$, CsF, or CsCl.

24. A process for making a semiconductor device according to claim 14, wherein the barrier film has a thickness of less than 100Å.

25. A process for making a semiconductor device according to claim 14, wherein the barrier film has a thickness ranging from approximately from 20Å to approximately 75Å.

26. A process for making a semiconductor device according to claim 14, wherein the transition metal is selected from the group consisting of copper, silver, gold and platinum.

27. A process for making a semiconductor device according to claim 14, wherein the transition metal comprises copper.

28. A process for making a semiconductor device according to claim 14, wherein the substrate material comprises a semiconductor.